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**Cover:** Interior of the 74th St. Power Station**Frontis:** Giant transformers*(Courtesy Allis-Chalmers Electrical Review)***Editor for this issue:** H. F. Ferry, Jr.**Members of The Engineering College Magazines Associated**

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# Power For Subways

HERBERT B. REYNOLDS, M.M.E. '15

**T**HE largest subway system in the world is that of the Municipal New York City Transit System, which is a consolidation of the Interborough Rapid Transit Company, The Brooklyn-Manhattan Transit Company and the Independent System. These original systems are operated as three separate divisions and are designated as the IRT, BMT and IND Divisions respectively. The rapid transit portion of the system, that is, the elevated and subway lines, consist of 740 miles of track and 242 miles of route. Some lines have only two tracks, others three tracks, while most of the main lines consist of four tracks, two express and two local. All of this trackage is not in subways as the old elevated system is entirely overhead while part of the the older subway system is overhead. In addition to the Rapid Transit Lines, the New York City Transit System comprises 370 miles of trolley car track, or 189 miles of route and 125 miles of bus route. There are a number of privately operated bus and trolley lines in the city which are not a part of the New York City Transit System.

Before describing the power facilities of the present rapid transit lines it might be well to review the history of power as applied to the propulsion of street cars, elevated lines and subways. There are still many people living who remember the horse cars of the last century as a small four wheel affair with open platforms front and rear which exposed the crew to all kinds of weather. It is recalled that many of the drivers wore full beards which became a mass of ice during cold weather. A small stove

was provided inside the car for the comfort of the passengers and straw was quite often spread upon the floor in which one could bury his feet. The motive power consisted of two horses with additional horses stationed at the hills which could be hooked on ahead of the regular horses in order to help the cars up the hills.

The first improvement in the method of propelling street cars was the cable system. This consisted of a moving cable located under the middle of the track. A slot was provided in the street bed through which the "grip" passed. This "grip" was fastened to the car and by a system of levers the car operator could cause it to engage and disengage the cable. The source of power for the cable consisted of central power stations, which contained steam engines and a system of large sheaves which transmitted the power to the cables

in the street. One of the illustrations shows a view of the engine room of the cable power station for the lower Broadway Line in New York City. This power station was located in the basement of the building which still stands on the northwest corner of Broadway and Houston Street. There are two units shown, one probably for the line south of the station, while the other was for the line north of the station. The steam engine for one unit can be seen at the extreme right of the view, while the sheaves around which the street cable passed are in the lower center of the illustration, the street cable passing out to the left under the floor. For those who enjoyed watching the "wheels go 'round", these old cable power stations were most fascinating places, quite different from the modern power station where it is difficult to find a single moving part. Although the cable system

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## THE AUTHOR

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**HERBERT B. Reynolds** returned to Cornell after working for a year in the shops of the Westinghouse Electric and Manufacturing Company and received the degree of M.M.E. After a short time spent in the Turbine Test Department of the General Electric Company he accepted the position of Assistant Engineer in the Motive Power Department of the Interborough Rapid Transit Company. On July 1st, 1942, he was promoted to the position of Superintendent of Motive Power of the IRT Division of the New York City Transit System, which Division was formerly the Interborough Rapid Transit System.



Herbert B. Reynolds

is still used in a few places such as San Francisco where the hills are long and steep, its general use was very short lived as it was soon replaced by the electric trolley car.

### Introduction of Rapid Transit

The first successful attempt to introduce rapid transit in New York City was the building of the elevated lines in the eighteen hundred and seventies. During the first quarter century of operation of the elevated lines the motive power was in the form of small steam locomotives. However, by the close of the nineteenth century electric propulsion had been demonstrated as a practical means of moving trains, so it was logical to electrify the elevated lines with an increase in efficiency in operation and the elimination of smoke and cinders from the city streets. In passing, it is interesting to mention the fact that the last two old steam locomotives which were still owned by the Transit System were contributed to the recent scrap drive.

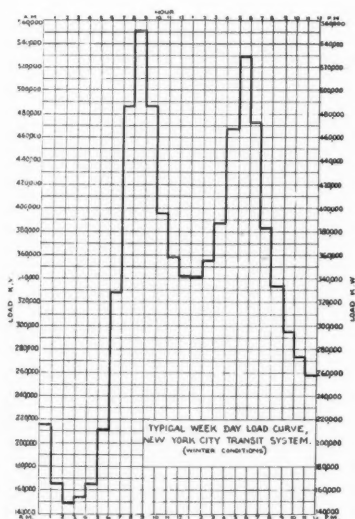
The introduction of electric propulsion in the railway field made subways possible so in 1904 the first subway system was placed in operation in New York.

Subway trains have a maximum of ten cars and attain a speed of about 45 miles per hour. During rush hours the headway between trains on some of the main lines is less than two minutes. This close headway necessitates a very high rate of acceleration which in turn imposes a very high power demand on the system when trains start, a ten car train requiring at least 4000 Kw. The power demand decreases rapidly as the train gains speed so that for all trains on the system the average power requirement is between sixty-five and ninety Kw. per car depending upon the type of service and the size of car. This includes trains in motion as well as those standing in stations while taking on and discharging passengers. About 4.25 Kw.-hrs. is required to propel an average subway car one mile.

Subway traffic being dense as it is, with frequent stopping and starting of trains, justified the low voltage direct current third rail system instead of the overhead high volt-

age alternating current system. The current is supplied to the third rail at a voltage of between 600 and 625. However, as the subway system extends over a very large territory it would not be practical to generate the power at this voltage, and so the power is generated in a few power stations as alternating current and at a high voltage. This is more suitable for transmission over the required distance to the various substations, where it is transformed to direct and to the proper voltage for use in the car motors.

The IRT Division of the system has two power stations. One is located at 59th Street and 12th Avenue, while the other is on 74th



Street near the East River. The BMT Division has one power station located on Kent Avenue in Brooklyn. The IND Division purchases its power supply from the local power utility.

### Power Systems

The IRT and BMT power systems are very similar and so the description of the IRT system will serve the purpose of this article. Both the 59th Street and 74th Street Power Stations were equipped originally with reciprocating steam engines. These engines are of the angle compound type, the high pressure cylinder being in the horizontal position while the low pressure cylinder is the vertical position. The high pressure cylinders

have a diameter of 42", that of the low pressure cylinders is 86", and both have a stroke of 5 feet. Each unit consists of two engines with a 7500 Kw. generator between them, the revolving field of which is 32 feet in diameter. These engines were the largest ever built for power station use and represent the latest development of engines for this service before the steam turbine entered this field.

Upon the extension of the subway lines additional power facilities became necessary. The first method of meeting the increasing demand was to install a turbine on the exhaust of each of five of the engine units at the 59th Street Power Station. With this arrangement the steam leaves the engines at atmospheric pressure and passes to the turbine where it is expanded down to condenser vacuum developing 7500 Kw. in the turbine. In this way the capacity of the five engine units was doubled.

### Removal of Units

The next step was to remove four of the engine units at the 74th Street Power Station and install three 30,000 Kw. turbine units in the space made available. The next increase was obtained by removing an additional engine unit from the 74th Street Power Station and the installation of a 60,000 Kw. turbine unit. Three 35,000 Kw. turbines were also installed at the 59th Street Power Station at about the highest capacity that could be obtained. This was accomplished by removing overfeed Roney stokers and installing underfeed stokers which more than doubled the capacity of the existing boilers. At the present time the two power stations of the IRT Division have a combined generator capacity of 400,000 Kw., while the BMT power station has a generator capacity of 220,000 Kw.

The power station of the BMT Division has been modernized by the addition of two high pressure boilers and two high pressure 18,750 Kw. turbine units. These two turbines exhaust into the headers of the original station which operates at a pressure of 200 lbs. per sq. in. The addition of these two high pressure units not only added to the capacity, but reduced



the coal consumption tremendously. Thus with this most recent addition to the Kent Avenue power station, the power supply for transit in New York City has gone through all the development stages starting with horses and ending with modern high pressure, high superheat turbines.

Both the IRT and BMT power stations generate three phase, 25 cycle current at 11,000 volts which is the transmission voltage in most cases. However, the IRT Division steps a portion of its power up to 19,000 volts for transmission to a few of the more distant substations. The reason for the 25 cycle current is that when rotary converters were first developed they would not operate satisfactorily on 60 cycle current which is standard for general power and light supply. However, at the present stage of the art, 60 cycle rotary converters are satisfactory and in addition the mercury arc rectifier is replacing the rotary converter for supplying railway power.

#### Transmission of Power

The power is transmitted from the power station to the substations through three conductor, lead covered cables placed in ducts under the streets. Upon reaching the substations it is transformed down to 625 volts direct current for use on the third rail. The IRT Division has twenty-six substations, twenty-four of which contain rotary converters and are manually operated, that is, an operator is required to be in attendance. Another substation is equipped with rotary converters but is operated from another substation through a remote control system. The newest substation of all contains mercury arc rectifiers and is operated from another substation. The substations are distributed over the system so that the distance between the substations and the third rail is kept at a minimum. The 625 volt direct current in most cases is transmitted to the third rail through single conductor cables—while another single conductor cable is used for the return or negative current. However, in some instances a common cable is used for both the positive and negative currents. This type of cable contains two conductors, one

inside the other, with a layer of insulation between and is called the concentric type of cable. The inner conductor is used for the positive feed to the third rail while the outer conductor carries the current back to the substation. There are about one thousand miles of cable in the IRT Division.

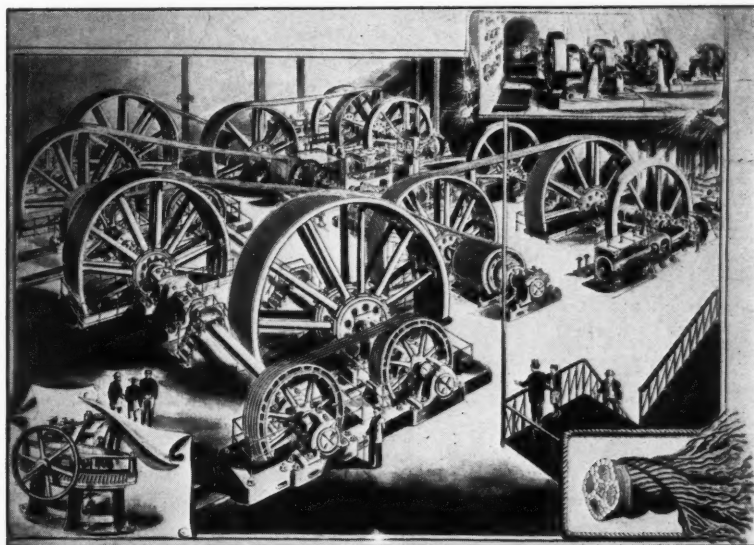
#### Protective Features

The power system has a great many protective features the purpose of which is to isolate electrical trouble which may occur in any piece of equipment or cable so that it will not effect the entire system. Some of these features should be mentioned:

First, there is the protection of

a particular section of the third rail by operating the nearest box. This not only cuts the power from the third rail but also rings an alarm in the substations and also in the power system operator's office. The location of the trouble may be determined by counting the number of strokes on the gong.

The principle purpose of the power system is to produce power for train propulsion. However, there are other services which must be provided by the Motive Power Department. For example—power for lighting the subway and stations, power and compressed air for the signals and track switches and compressed air for operating the drainage pumps for which trans-



Interior of early day cable power station

the high voltage feeders to the substations. These feeders are protected against overload or short circuit by oil switches at each end which open automatically if trouble occurs on that particular cable. Likewise, the direct current feeders which carry the current to the third rail are protected by circuit breakers at each end. In addition to these automatic features, a system is provided whereby the current may be cut off from any section of the third rail by track walkers or others in the event of a wreck or other accident which may make "killing of the third rail" desirable. This system consists of boxes similar to fire alarm boxes distributed at frequent intervals throughout the subway. Anyone may "kill"

formers and compressors are located in various substations.

As mentioned before, the IND Division purchases all of its power from the local power utility which delivers 13,500 volt, three phase, 60 cycle current to the substations which generally are of the mercury arc rectifier type. However, there are a number of rotary converter substations supplying the IND Division. The mercury arc rectifier substations of the IND Division are located in underground rooms adjacent to the subway. This reduces the length of the direct current feeders to a minimum. All substations of the IND Division are automatic and are controlled from central points requiring no

(Continued on page 28)

# Heat Transfer Laboratory

DAVID M. DROPKIN, Ph.D. '38

A recent addition to the facilities available in the Sibley School of Mechanical Engineering is the newly constructed and equipped Heat Transfer Laboratory. This laboratory is located at the west end of the West Mechanical Laboratory. It consists of a constant temperature room, a cooler room, and an instrument room. The constant temperature room is 26' by 29' with a ceiling height of 12'; the cooler room, 7' 7" by 14', with a 12' 6" ceiling. The instrument room is 10' by 34', with a 12' ceiling.

The constant temperature room and the cooler room have a common wall, 12' by 14'; while the instrument room has a side common to both the constant temperature room and the cooler room. The constant temperature room has a "super-freezer" door, 4' 6" by 6', and two "plug doors," 2' by 2' each. Pipes, wires, etc., leading to the instrument room are introduced through the plug doors. The cooler room has a 2' 6" by 6' "super-freezer" door leading to the instrument room. All the walls of both the constant temperature room and the cooler room are insulated with 8" of cork applied in two layers. The floors have a base of 4" of concrete upon which is placed 8" of cork and 3" of reinforced concrete. On the north side, the east end, and 11' of the south side of the constant temperature room, the insulation rests against the brick walls of the building with 1 to 1½ inches of plaster between the walls and the cork. The windows are covered with masonite resting against the sash. The space between the masonite and the cork blocks is filled with ground cork. The ceiling of this room consists of a suspended steel deck, above which is 8" of cork with 1" of cement plaster on top of the cork. On the south

side of the cooler room, the insulation is placed against a 6" double-sided wooden partition. The inner surfaces of the walls of both the constant temperature room and the cooler room are plastered with asphalt emulsion and painted with a white cold storage paint. The walls, where exposed to the instrument room, are plastered on the outside with cement.

## Cooling Equipment

The cooling equipment has a capacity of 15 tons of refrigeration and consists of a 4" by 4" ammonia compressor, a 5¾" by 4" booster compressor, a 16" sixteen-pass condenser, a water-cooled intercooler, a liquid and gas cooler, a liquid receiver, an oil separator, pressure gauges, controls, etc. The equipment is located just outside the air cooler room. Within the cooler room is located the accumulator with float control and the cooler with its fan and motor.

The air which is supplied to the constant temperature room is cooled in the cooler room and then blown into the constant temperature room at the required temperature.

This method of air cooling minimizes radiant heat interchanges between objects within the constant temperature room, since the coldest object within the room is the air duct supplying the colder air. The duct is only slightly colder than the air of the room. This arrangement makes it possible to maintain a uniform temperature throughout the room by controlling the air distribution. During the tests thus far conducted, the inlet air temperature has been about 6°F lower than the average air temperature within the constant temperature room.

The air temperature in the constant temperature room is thermostatically controlled and the thermostat can be set to maintain any desired temperature between minus 50°F and plus 100°F. A carefully designed distributing system discharges the air near the ceiling in such a manner that at no time during a test was the difference in temperature, at the same level in different parts of the room, more than 1°F. The return opening is located near the floor.

## THE AUTHOR

**COMING to Cornell from Nyack, N. Y., Dr. Dropkin received his M.E. degree in 1933, his M.M.E. in 1935, and his Ph.D. in 1938. He became a Research Associate in the University and an Instructor in Mechanical Engineering, both positions which he now holds.**

**Dr. Dropkin has done a good deal of research at Cornell, mainly in the fields of psychrometry, radiators and convectors, thermal conductivities, and insulating materials.**



### Test Room

Inside the constant temperature room is located a radiator and convector test room. The test room is used for research and testing purposes. It was built to conform, in so far as it was possible, with the American Society of Heating and Ventilating Engineer's test code specifications. The construction of the room was in sections so that it could be easily taken apart. The room is 15' long, 12' wide and 8' 2" high. Each section, except those of the floor, consists of a wooden frame made up of 1" by 4" studs placed on 16" centers. The frame is covered with  $\frac{1}{8}$ " thick hard pressed masonite board. The floor is constructed in the same manner as the walls and ceiling, except that the joists are 2" by 4" and the

mocouples and five thermometers are installed to measure the air temperatures of the constant temperature room as well as the air and surface temperatures of the walls, floor, and ceiling of the test room. Air temperatures of the test room are measured at 9", 30", and 60" above the test room floor and at 9" below the ceiling, at five different stations. The wall temperatures are measured 5' above floor level, while the floor and ceiling temperatures are measured at their respective centers.

A 12-point, photoelectric action, potentiometer-recorder is used to record the air temperatures within the test room at three stations. The remaining thermocouples are connected to a semi-precision portable potentiometer.

The device to show the effect of radiation on the readings of the dry-bulb thermometers was originally used in connection with the work on psychrometry. At present, this device is used for student instruction.

Closely connected with the new Heat Transfer Laboratory is the Psychrometric Laboratory. This laboratory is located in the basement of East Sibley. It is 18' 10" long, 15' 5" wide, with a ceiling height of 8' 6". The walls and ceiling are insulated with mineral wool. The air temperature within this laboratory is maintained constant by a simple device which mixes outside air with recirculated air. With this arrangement 600 c.f.m. of constant temperature air is supplied through several nozzles at a



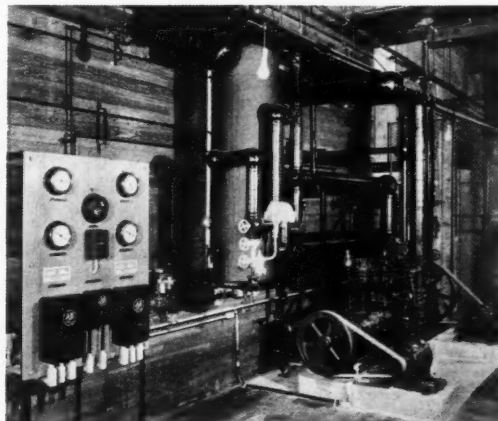
Temperature recording instruments

masonite board is  $\frac{1}{4}$ " thick. A small section of the floor which supports the radiator or convector is made of  $\frac{3}{8}$ " thick wood flooring in order to provide extra strength and rigidity. The masonite wall back of the radiator is covered with  $\frac{1}{2}$ " plaster board. The entire inside surface of the test room is painted with flat gray paint. To provide access to the room a standard 1  $\frac{1}{8}$ " wooden door is located at the southwest corner of the room. This door, however, is never opened when an experiment is in progress. The test room can be insulated, partially or completely, with any desired thickness of insulation. Provision is also made for installing windows in any wall of this room.

Thirty copper-constantan ther-

In the instrument room, there are many instruments and apparatus which are used on various heat transfer projects. Among them is a guarded hot plate, a drying oven, a device for measuring the effect of radiation on the readings of the dry-bulb thermometer, resistance thermometers, radiometers, recording and indicating hygrometers and psychrometers, hypsometer, air thermometer, globe thermometers, etc.

The guarded hot plate is used for determining the thermal conductivities of insulating materials. It may be used for either research or commercial work. The drying oven is intimately associated with the hot plate, since all materials should be dried before going into the hot plate.



Ammonia compressors for cooling

velocity of 1000 feet per minute, at the nozzle. The nozzles and the recirculated air ducts are located near the north wall. An opening for the excess air in the room is located at the north-east corner, about six inches above the floor. The size of this outlet is regulated manually. To prevent any interference in the air circulation due to the opening of the door, two doors are arranged in such a manner that one can be closed when the other is opened, thus permitting entrance or egress to or from the room without direct outside connection.

The constant temperature room as well as all other equipment in the Heat Transfer Laboratory are now used to their fullest extent for research, testing and teaching purposes.



# Superfinish --- The Ultimate In Surface Finish

GERALD R. SCHILLER, ChemE '45

**E**ARLY in 1934, Mr. D. A. Wallace of the Chrysler Corporation conceived of the principles underlying Superfinish. The original reason for the development of Superfinish was to prevent brinelling of the rear wheel bearings of automobiles in long distance shipping. Brinelling is the indentation in the surface of the portions of the bearing which carry the practically static load of the auto when blocked in place for shipping. When the machine was operated by the purchaser, a buzzing or clicking sound, caused by these depressions, annoyed the passengers. While working on a process to prevent this brinelling, Mr. Wallace made many interesting and useful discoveries about metallic surfacing which led to advances in the finishing of many automobile parts and other mechanical devices.

In analyzing the surfacing problem, it was found that machined parts have a finish produced with three major objectives; to produce a dimension, to produce a finish, and to produce a finish and a dimension simultaneously. The latter is the main problem since severe machining methods disturb layers of metal for considerable depth, and are unable to remove these layers so as to reach the undisturbed crystalline structure beneath without continually reproducing more fragmented and smear metal material.

"Superfinishing is the name of a method of mechanically developing on metal parts a surface finish which is optically smooth and metallurgically free of any fragmented or smear metal. The resulting Superfinished surface is a true, geometrically developed, wear-proof bearing area, free of oil-film-rupturing protuberances, and accurate to within submicroscopic

range." (from *The Story of Superfinish* by A. M. Swigert, Jr.).

For a practical description of Superfinish, an analogy is formed between a block of steel and a block of ice. When a fresh coat of snow has fallen upon a block of ice, this snow will support a person. It will be compressed, and yet not become an integral part of the ice block, although it is of the same chemical composition, for it is of different physical condition. With a simple scraping operation, the amorphous snow may be removed and a new crystalline surface exposed. If a block of steel has been machined by any process which develops heat and pressure, it will have layers of deformed crystals. Although these crystals are of the same chemical composition as the block, they are of different physical condition. The block will have lying on its surface a layer of fragmented metal similar to the snow on the ice. That process which can remove this amorphous fragmented metal from the surface without disturbing the crystalline structure beneath is then the desired process. This is the basic principle of Superfinish.

## Process

The process of Superfinishing is merely a gentle scrubbing of the service to be finished with the correct abrasive in order that all the amorphous metal be removed. Superfinishing is a very flexible process having been used on parts a fraction of an inch in diameter up to parts of the largest diameters commercially produced, as well as on irregular surfaces as cam contours, and plowshares. It has been applied successfully to cast iron, steel, aluminum, copper, chromium, glass, wood, tin, and fiber. The Superfinishing process can be held to any degree of commercial ac-

curacy. This includes tolerances of plus or minus five ten-thousands of an inch.

Since Superfinishing is a process for refining surface finishes, there must always be a previous reducing or dimension production operation. Of great importance is the quality of the surface produced by machining methods previous to the Superfinishing process. A surface to be Superfinished can be prepared by any commercial machining method. Experience has shown, however, that different materials require different operations. Cast iron parts may be ground, while non-ferrous metals as aluminum, brass, and copper require a turning operation for maximum efficiency. It is best to have a surface of uniform depth or height of defect no matter what type of preparatory operation is used.

The more exact the primary dimensional accuracy, the more accurate the Superfinishing operation becomes. It has been found that it is less expensive to correct the causes of dimensional inaccuracies in the preliminary operation than in the Superfinishing process. In some cases, as the photomicrographic study of surfaces has shown, the effect of severe primary finishing operations could not be removed by Superfinish. If dimensional irregularities of any magnitude are produced by preliminary operations, the time of Superfinishing is increased. The maximum operating efficiency of this process requires that the surface be uniform and dimensionally accurate.

It has been found that the greater percentage of surface roughness is removed during the first five seconds of the Superfinishing operation. (The entire operation takes about a minute for parts of ordinary size such as pistons and



brakedrums). As the surface is ground and the bearing area increases, the glazed stone and the lubricant viscosity begin to take effect and the rate of removal of material is slowed up, resulting in the removal of the fragmented, amorphous metal, without continually producing more fragmented material.

#### Abrasives

Bonded abrasives in which relatively coarse grains are firmly imbedded are the tools used in the Superfinishing process. The cutting points of the grits are always available. After the single abrasive grits have done their work, they are washed away and do not remain between the stone and the work, thus preventing the blocks from producing additional scratching or burnishing action. The abra-

sive blocks are made to fit the work. The materials commonly used are silicon carbide and aluminum oxide. The silicon carbide stone is used in the finishing of materials with low tensile strength, such as cast iron, aluminum, brass, and bronze. Aluminum oxide abrasives are more suitable for materials having a high tensile strength, such as carbon steels, alloy steels, and other materials of considerable hardness. The bonding of the abrasive materials, that is, binding the grits or abrasive together, for the most part, is produced by either of three methods; vitrified bonding, silicate bonding, or elastic bonding. Vitrified bonded abrasives are used for the hard steels, while elastic bonded abrasives are used for the softer materials. The grain size varies from one hundred and eighty mesh,

for brake drums and clutch plates, to five hundred mesh, for camshafts and crankshafts. The mesh number is the number of meshes per lineal inch through which the grains will pass.

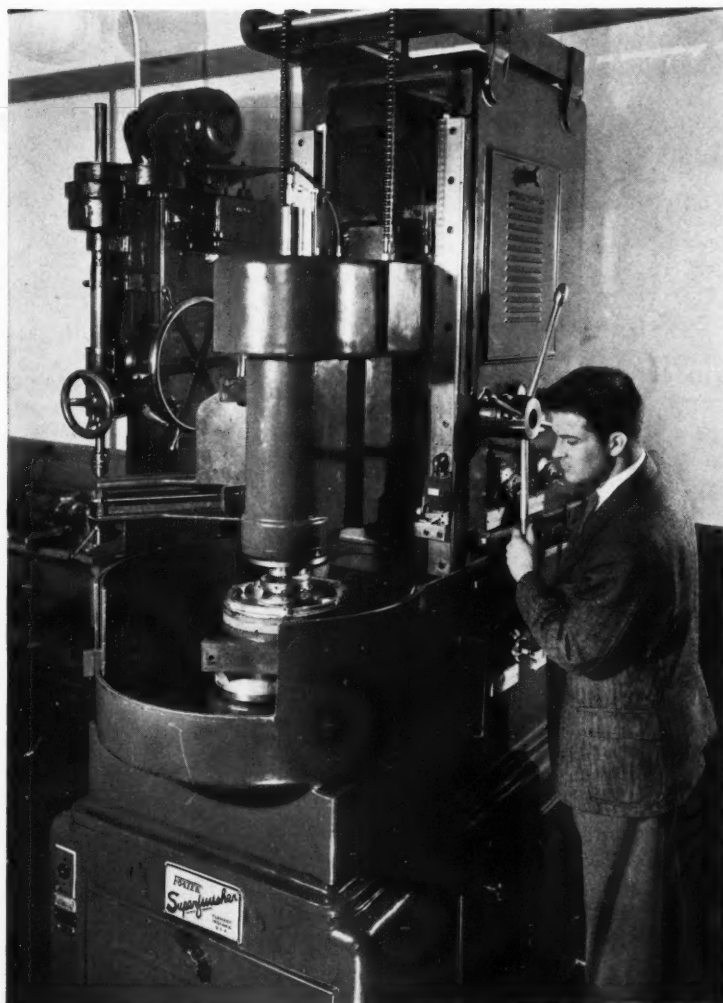
In the actual Superfinishing process, of great importance is the random motion of the finishing stones. For flat surfacing, a rotary motion is employed, while for round work reciprocatory motion is used to derive full benefit of the surface abrasive contact with the work. This so-called multimotion is an integral part of Superfinishing. It provides a multiplicity of both changing speed and direction of each individual abrasive grain. This multimotion allows thousands of small cutting tools to operate simultaneously. Each of these tiny cutting tools through high speed, short stroke reciprocation, cuts a small particle from the surface. Before this chipped particle can break through the thin film of lubrication on the abrasive, the abrasive abruptly reverses its motion and the pressure is applied to the opposite side of the grain. This quick reversal allows any broken particles to be removed immediately by the lubricant. This cycle is repeated as many times as the reciprocation provides.

Superfinished surfaces differ from other surfaces in that any defects in them will be the result of previous operations. Defects produced by Superfinish are produced below the surface, thus the superiority of Superfinishing over any other surface producing methods. Superfinishing develops a smooth, geometrically true surface by eliminating the surface points and projects above the contacting surface, thereby preventing rupture of oil films under pressure and permitting increased loads. Since these surface points and projections are absent, there is less friction in Superfinished surfaces. As a result, Superfinished parts are more efficient than parts surfaced by other methods.

Mr. D. A. Wallace has received the Modern Pioneer Award for his work in developing Superfinishing. His work on this most advanced form of surface finishing has given impetus for a great forward step in machine surface finishing in the mechanical world.

A typical installation

—Courtesy Chrysler Corp.



# NEWS OF THE COLLEGE

## Atmos Meeting

At a recent meeting of Atmos, honorary mechanical engineering society, an informal discussion was held among the members of Atmos and members of the faculty of the mechanical engineering school. The discussion dealt chiefly with the correlation of practical and theoretical training given at Sibley College. Several of the students pointed out that the theoretical work given here was not correlated to practical work, and referred to Annapolis, where students are taken to a machinery laboratory following a lecture concerning the theory. This view was upheld by Professor Mackey.

The opinion was expressed that there was not sufficient time in a four-year course to cover adequately both theory and shop subjects, but Clyde Loughridge maintained that there should be, nevertheless, at least one "grease-and-overall" course.

Several of the professors brought out the point that summer work could be used effectively to make up for the deficiency in shop courses, which would prevent engineering graduates from being laughed at by machinists and plant workers.

Another question discussed at the meeting was "who grades the professors?" In regard to this question, John McDouglas brought out the point that better classroom spirit would prevail from both the student and faculty point of view, if the faculty were expected to visit their colleagues' recitations. It was contended that if the Dean or a professor might be expected to drop in on any class, both the instructor and students would spend more time in preparation.

Later, Dean Hollister addressed the gathering and summarized the problems facing the engineer in the next fifteen years:

- (1) We must win the war.
- (2) We must face a post-war world that is prostrate. We must rebuild entire nations, solve their

problems of industry, of building homes, of providing food, and of gaining happiness.

- (3) We must accept as Americans the greater part of this burden of reconstruction.

- (4) We must, to prepare for this responsibility, understand the histories of the countries involved, their customs, and basic economic problems.

Dean Hollister's talk closed the meeting.



W. E. Irish, M.E. '12

## Engineer Banquet

THE CORNELL ENGINEER held its annual banquet on January 15th at the Victoria Inn. The principal speaker of the evening was Mr. W. E. Irish, M.E. '12, editor of "Industrial Equipment News."

Elections to the Senior Board of the ENGINEER were announced at the banquet as follows: Jack McMinn, CE '44 was elected editor-in-chief; Robert Rochlin, EE '44, managing editor; Gerald Schiller ChemE. '45, assistant editor; Donald Lueder, CE '44, Melvin Garritt, CE '44, Horace Ferry, ME '44, and H. Sherman Burling, Jr., AE '44, associate editors.

David Esperson, ME '44, was named business manager and treasurer; Thomas Dent, ME '44, advertising manager; Kenneth Kander, ME '44, circulation manager; Martin Gleich, CE '44, assistant ad-

vertising manager; and Robert Shaad, AE '44, assistant circulation manager.

## Engineer Competition

HEAR ye, hear ye, all would-be Brisbanes and Morgans and any other of you red-blooded Americans. The CORNELL ENGINEER is holding its semi-annual competition of both the editorial and business boards on February 10 in its offices on the fourth floor of Lincoln Hall. The try-outs will be relatively short, offering ample opportunity for demonstration of journalistic and business ability, and will lead ultimately to positions of Editor-in-Chief and Business Manager of the magazine. No previous experience is necessary, just a bit of this war-time spirit. So come on some of you bustling freshmen and sophomores, here is your opportunity for good experience and time well spent.

## New Navy Power Plants

SUPERIORITY of American warships in recent battles has been caused in part by secret improvements in their steam turbines, George B. Warren, designing engineer with the General Electric Company, intimated in a talk given on Monday, January 18, to a group of Cornell engineers and student officers in the Naval Training School.

Although the details of these improvements are military secrets, he revealed that until a few years ago the designs for steam turbines of all the navies of the world, including the U. S., Japanese, German, and British, came from a single office in England. Recently, however, the U. S. Navy has been designing its own power plants for warships.

"These designs," Mr. Warren said, "are adaptations to maritime use of the great advances made since 1919 in the design of steam turbines for central power stations. Before 1936 new high-speed turbines with double-reduction gears had brought an economy in fuel on

U. S. Naval vessels of 25 per cent. Secret improvements since that time have probably brought about another 20 per cent increase in fuel economy." Reduction in size of power plants and in fuel consumption, he pointed out, means an increase in the space available for carrying ammunition.

Drawing on his 23 years of experience as a designer of turbines in the Schenectady plant of the General Electric Company, Mr. Warren traced the steps in improvement of steam turbines since 1919. "It was all a matter of competition," he said. "First one company would advance a step, and then the engineers of another would work out a way to go a step further. It was friendly competition, because most of the engineers knew each other, and it was fun. But it brought astonishing results."

He said, for example, that usable steam pressure had gone from 200 lb. per sq. in. to 2400 lb. per sq. in. since 1919. "As a result, the United States produced six times as much electric power from steam in 1942 as in the first year of the First World War and used only twice as much fuel." He predicted further startling advances after the present war, when expansion and rebuilding of central power stations will be resumed.

Mr. Warren's son, Robert E., is a senior in the Sibley School of Mechanical Engineering at Cornell.

### **Navy's Diesel Lab.**

A wide variety of Diesel engine equipment is to be found in the new Diesel Laboratory of the Naval Training School. This will enable the student officer upon completion of the course, to be familiar with any type of engine he is likely to find on the seas. Already an extension of the temporary building is planned to be built toward Olin Hall to house the small engines.

The engines available vary in weight from a few hundred pounds to many tons. The largest engine is a twelve-cylinder V-type auxiliary to supply electricity for a large ship. Another large engine is of a submarine type, and is about 1936 vintage. This 27,000 pound giant was one of four such engines for a submarine—one of the two

driving the propellers, the other two being used to generate electricity for the batteries which must be used beneath the surface. It contains eight in-line, double-acting cylinders. Two more large engines are expected soon. Shut off by itself in a soundproof room is a fairly new development in marine engineering—a radial pancake engine. A propeller shaft is to be attached to this engine, with a variable pitch propeller at one end submerged in water to act as a brake at low horsepower. This engine, as in the case of the other large ones, is mounted on a concrete block about seven or eight feet thick. Among the other engines is a Fairbanks-Morse from a tug boat, a small Gray Marine engine, a Buda engine and even a German Junkers engine. One of the engines, an auxiliary from a small boat is used for troubleshooting. Tests are made on this engine to determine the power output, fuel consumption, etc.

### **New Course**

BEGINNING this coming term, a new one credit hour engineering course, 3X51, will be open to members of the Atmos society.

The course is a result of the recent meeting in which a discussion took place between Atmos members and faculty. The students argued that they were not getting enough practical training. This course, which was suggested by Professor Mackey, Heat Power Engineering, is offered largely to find out if the students will benefit by such a shop course. Classes will consist of experimental work in the mechanical laboratories. Various special tests will be set-up and conducted for the University.

Under the directorship of Professor Mackey, and with Sherwood Holt representing Atmos, the course will provide students with some of the practical experience and engineering problem experience they desire. The work will also be constructive: projects will be of importance and will be carried to completion.

In summary, 3X51 is a new course open to Atmos members and which, for a total of 40 hours of work, gives one hour of credit.

### **ASCE Luncheon**

ALTHOUGH representatives from many neighboring schools were kept from attending by the gasoline shortage, the Cornell branch of the ASCE held a successful convention on January 9th. The highlight of the meeting was the luncheon at which Edward Miller '43 delivered his prize-winning talk on the "Alcan Highway." Professor R. Y. Thatcher also spoke on the "Effect of the War Program on Property Law." About thirty men attended the luncheon.

At its elections on January 18th, the ASCE chose the following men as its officers for the coming term: President, William Correll '43; Vice-president, Rogers Thackaberry '45; Editor of "Rivet Rattle," Robert Hickman '43; Secretary, Theodore Van Hynning '44; and Treasurer, Melvin Garritt '44.

### **Council Elections**

The junior classes of the five schools each recently elected a representative to the Student Engineers Council. They are as follows: Jackson R. Pope, '44 AE; Howard A. Parker, Jr. '44, ChemE; William R. Hughes III, '44 CE; Robert H. Garmezy, '44 EE; and William S. Wheeler, '44 ME. Normally the main function of the Council is to plan, sponsor, and finance the annual Cornell Day Engineering Show. Although there may be no show this year because of war conditions, the Council will be kept intact, since it is felt that there is a definite need for a permanent organization to represent students in the College as a whole.

### **Navy Graduation**

LIEUTENANT Commander Arthur S. Adams, U.S.N. (ret.), former assistant dean of the College of Engineering at Cornell and first director of the Diesel engine course in the Naval Training School on the campus, returned from Washington on January 8 to address another graduating class of Naval Reserve officers who have completed the Diesel course. Lieutenant Commander N. R. Sparks, who succeeded Dr. Adams in charge of the course, presided.





**Prof. Clark**

### **Prof. Roy E. Clark, M.E.**

**N**OT just a Heat Power expert but also somewhat of an authority on the manufacture of newsprint, the administration of first aid, and scouting, Assistant Professor Roy E. Clark has been at Cornell for a good many years.

Born and brought up in Norwood, New York, Prof. Clark attended the regular grammar and high schools, but, at the same time, he worked for a paper manufacturing firm, the Norwood Paper Company. Although he has never since had the opportunity to do any more work along that line, Prof. Clark feels he still knows something about this industry.

A State Tuition Scholarship helped him on his four year course through Cornell, begun in 1908. While here, Prof. Clark devoted the major portion of his time to studies, although he did try his hand at a few extra curricular activities, including a little cross country running. Upon graduation as M.E. in 1913, he received a position in the Heat Power department here as instructor.

In World War I, Prof. Clark was attached to the Ordnance Department doing engineering work. He was stationed at a shell loading plant and quite enjoyed his period of service there. During his summer vacations, he has done research work for General Electric, Westinghouse, and others. Most of this has involved turbine work in which he had ample opportunity to use his Heat Power knowledge.

Prof. Clark has two important in-

# OUTSTANDING

terests outside of teaching. He has been active in Scouting for about 15 years and was a Scoutmaster in Ithaca for five years. In addition, he is very much interested in the American Red Cross First Aid, and, as head of all the war emergency First Aid work in Tompkins County for the past year, he has been able to put into practice, this life long interest. Prof. Clark is also famous around the Heat Power department as an amateur weather prophet of no mean ability.

With the exception of the World War period, Prof. Clark has been teaching Heat Power continually since 1913; it was in 1919 that he was promoted to the position of Assistant Professor.

Prof. Clark belongs to Acacia fraternity, the Society for Promotion of Engineering Education, and Atmos.

### **Ellsworth F. Filby, CE**

**E**LLSWORTH F. (Pete) Filby is another member of the outgoing senior board of the CORNELL ENGINEER. Pete started his career here in Ithaca some twenty-odd years ago. He left Ithaca and did not return until he was duly enrolled in the School of Civil Engineering as a freshman.

From Ithaca, Pete's father, who incidentally graduated from Cornell in 1917, took the family to Columbia, South Carolina. As with any engineer, life did not allow permanent settlement, and the family was soon on the move again—this time to Jacksonville, Florida. For a time Pete enjoyed the climate and "beauties" of Florida while his father worked as an engineer for the State of Florida. The family moved finally to their present home in Kansas City, Missouri. There Pete completed his grade school and high school education, and in the fall of 1939 enrolled in Cornell's School of Civil Engineering. Three factors influenced Pete's choice of Universities, two of them being his father and mother who are both graduates of Cornell, and the third being that he was offered a McMullen Regional Scholarship.

Pete's freshman year here at the University was rather uneventful. His only notable accomplishments, and rather conflicting ones at that, were that he managed to get eight hours sleep a night and make the Dean's List. Realizing that such an existence was healthful but uninteresting, he decided to participate in more activities on the hill. He joined Phi Kappa Psi fraternity where he is now house manager, at the start of his sophomore year and at about the same time went out for the business competition of the CORNELL ENGINEER. Since that time Pete has been steadily adding honors and accomplishments to his record. During his junior year, his three year Dean's List scholastic record along with his other activities won him election to Tau Beta Pi. He was also elected to the civil engineering honorary fraternity Chi Epsilon and last year became president of this organization. His presidency of the CE senior class and school honor committee also serve to keep him busy. He is, of course, a student member of the ASCE. He is in the Field Artillery and so may go most anywhere via Ft. Sill, Oklahoma.

Pete is a firm believer in a liberal education and so has mixed in Spanish and even a couple of music courses with his engineering studies. In him the CORNELL ENGINEER loses a good Circulation Manager. We thank him for a job well done.

"Pete"





# PERSONALITIES

## Clyde A. Loughridge, ME

ONE reason Clyde Loughridge hopes this war will end soon is so that he may go on an expedition with Captain George M. Sutton, well known former Cornell professor of Ornithology, to pursue his unusual hobby of bird lore. This has attracted Clyde's interest for years and to date he has seen about two-hundred different kinds of birds. At present, however, Clyde is a Cadet Captain in the ROTC Signal Corps. This May he expects to receive his commission as a Second Lieutenant and his time after that will be well taken up for a while.

Clyde came to Cornell from Lakewood, Ohio, induced by a McMullen Scholarship and the fact that his Dad is a Cornell man. He worked for his father, a consulting electrical engineer; but, desiring a broader foundation, he chose mechanical engineering, from which he felt he could enter with comparative ease into any branch of engineering he desired.

Since the fall of 1939, when he came here, Clyde has been out for the CORNELL ENGINEER and is now managing editor. He had gained no little experience in high school as business manager of the yearbook, which had a budget of over \$4,000. Previous to that year he

"Clyde"



spent a summer at the strange job of a skating penguin in a summer ice show at the Great Lakes Exposition.

He earned his numerals as a member of the Frosh Rifle team. Tired of squinting through a rifle sight Clyde turned his attention to the cheerleading competition in his Sophomore year, and he's been a member of that squad throughout these last three years in school. In the Spring of that year he joined Beta Theta Pi, and now holds the time-consuming position of secretary.

In advanced ROTC Clyde was elected to Scabbard and Blade and Pi Tau Pi Sigma of which he is treasurer. He has also spent part of one summer at Fort Monmouth. That same year he was on the Junior editorial board of the CORNELL ENGINEER and was elected to Atmos, of which he is now president.

Beside bird-lore, Clyde is also interested in amateur photography, and a variety of sports, including skating, baseball, tennis, skiing and golf, although he disclaims any proficiency in the last two. Last Spring he indulged in a new-found sport when he sailed home from school in an auxiliary cutter. How much they used the auxiliary is not clear.

This year Clyde was elected to Tau Beta Pi and Sphinx Head, two honors which he righteously deserves for his outstanding record.

His immediate future is well-outlined for him, but Clyde hopes that he will ultimately be able to obtain a position involving labor relations work, with the idea of finding solutions to labor problems which are fair to both management and labor.

## Robert H. Flack, ME

ROBERT Harold Flack, Jr., was born and raised in a Cornell atmosphere, as his father, Harold Flack, Arts '12, was the Chairman of the Cornellian Council here in Ithaca some years ago, and his mother graduated from the Arts College in 1916. His education



"Bob"

previous to that at Cornell was at the Westtown Boarding School, Westtown, Pennsylvania, where he spent five years.

Bob entered the ME school at Cornell in the fall of 1938, and did well from the start. He made the Dean's List, was drummer in the Freshman band, and went out for the CORNELL ENGINEER during his Freshman year. During his Sophomore year he branched out into new fields, going out for the Managerial Competition of the Ski Team and the Railroad Club. In this club he rose quickly to the office of President, which he held for his Sophomore and Junior years.

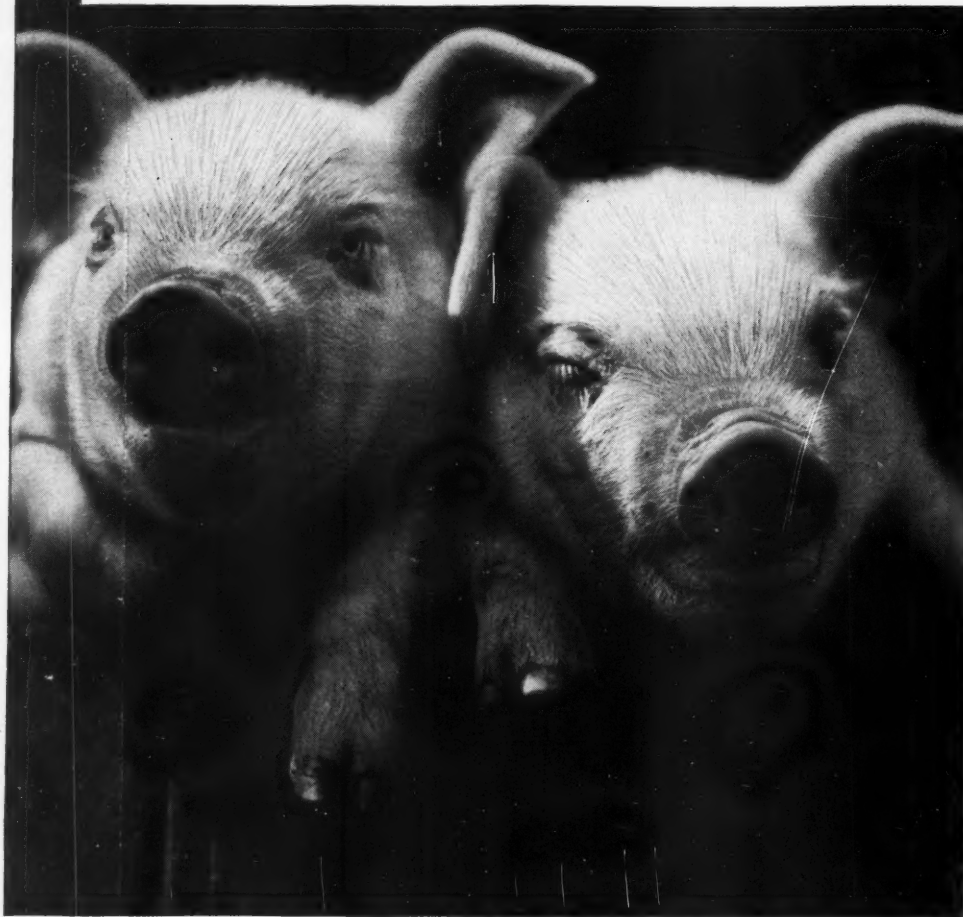
He became assistant manager of the ski team in his Junior year, and is now manager of the team in his senior year. During his Junior year he also went out for the advanced ROTC, and was elected to Pi Tau Pi Sigma, its honorary society. He received a sabre for military excellence in the Signal Corps, and was Secretary of the Officer's Club until that organization was disbanded this fall.

When Bob first arrived here he got an Undergraduate Scholarship which lasted two years; when that one stopped, he immediately got a McMullen Scholarship which he still holds. This year he became the Chairman of the ASME student branch at Cornell, and is also Social Chairman of his fraternity, Pi Kappa Alpha.

As was mentioned before, during his Freshman year Bob went out for the CORNELL ENGINEER's BUSI-

(Continued on page 26)

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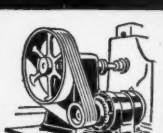
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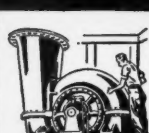
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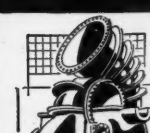
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## VICTORY NEWS

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**New A-C War Plants:** Two big new Allis-Chalmers war plants are now in operation "somewhere in the USA"...the second in a record 90 days after the ground was broken.

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*"The objects of this Society are to promote the welfare of the College of Engineering at Cornell University, its graduates and former students and to establish a closer relationship between the college and the alumni."*

## President's Message

Fellow Cornellians:

Everyone who has had an opportunity to hear President Day or Dean Hollister speak knows that the College of Engineering is doing a magnificent job toward fuller participation in the war. Its facilities are being used to the limit and its faculty is overloaded with work. This condition will undoubtedly continue for the duration of the war and the College, we hope will be ready immediately when peace comes to continue engineering instruction with the same high degree of efficiency that it had before the war.

In addition to its regular courses of instruction, the College is teaching Diesel engineering for assigned naval officers. Over five hundred of these have taken this work and ninety-four have just graduated. This work has necessitated the building of a new temporary laboratory directly south of Olin Hall near the old armory. An Ordnance Inspection course is being given to a large group of men and woman assigned to Civil Service. Steam Engineering instruction is just getting under way for about one hundred assigned naval officers. Courses in Electronics as pre-Radar work is being given to college men assigned to Civil Service. Curtiss-Wright Engineering Cadettes, one hundred and thirty-five strong, are being given a forty-four week course. This work, given in the College, is in addition to the training given to industrial employees outside Ithaca in special night courses in eighteen centers in the western part of the state in which over 12,500 are now enrolled.

These are young, ambitious war plant workers who wish to become more efficient and are anxious to assume added responsibility in the plants where they are working. Other special-purpose courses are in prospect, one of them for instance, is for undergraduate women now in attendance at Cornell in sub-professional engineering work. In this connection I would like to point out that Dean S. C. Hollister of the Engineering College has done an exceptionally fine piece of work in organizing and directing the instruction both at Ithaca and outside of that city.



George N. Brown, '08

It is a splendid contribution which he has made and is making to the prosecution of the war and reflects great credit on Cornell. Congratulations to Dean Hollister.

With the drafting of eighteen and nineteen year old students, the College is cooperating with the Army and expects a large number

of men in uniform to be assigned for special engineering training after they have received the basic three months training in Army camps. In addition to all this work planned by the College, facilities are provided in cooperation with the rest of the University for the Navy officers who are sent in large numbers for their three months indoctrination courses given by the Navy.

It must be realized that in all of the above work the College of Engineering is dependent on the support of many of the departments of the University at large. The success of its various teaching programs requires a considerable amount of teaching in the sciences and in mathematics. This latter instruction is not available within the college.

While it seems evident that the Engineering College will probably not suffer greatly from the effects of the war, other colleges, particularly the liberal arts, may have a very difficult time ahead. This is a matter of great concern to the Engineering College and to all engineering alumni. One of the greatest assets of our College, in addition to its outstanding engineering faculty is that it is located in the center of a great University where broad educational and cultural advantages can be had in practically unlimited fields. Along this line, President Day has recently said, "Cornell has much to offer in a war program and will not suffer as seriously as will institutions that lack strong scientific and technical departments. Our Medical Col-

*(Continued on page 30)*





# *The future will call for teamwork*

You are fitting yourself now to play a part in the immense rebuilding job that engineering will be called upon to perform when our victory has been won. Among the names that you will be able to count upon for teamwork will be that of Busch-Sulzer.



In facing the future, good judgment takes past performances into consideration. Busch-Sulzer built America's first Diesel engines. In the first world war, Busch-Sulzer built Diesels for Navy submarines. After the war, our Diesels won new laurels in commerce, industry and public utility service.



Today we are working all-out 'round the clock on Navy equipment and orders of high priority only. The Navy has added a star to our E for excellence of production. We have greatly expanded our facilities. These, with added experience and knowledge, will help us to do our share in the peacetime effort that will be the job of all engineers.



## **BUSCH-SULZER BROS.- DIESEL ENGINE COMPANY**

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**FEBRUARY, 1943**

# ALUMNI NEWS

## Sperry Praised

AN industrial firm with several Cornell graduates among its officers, the Sperry Gyroscope Co. of Brooklyn, makers of complex precision instruments, is highly praised for its vital wartime achievements by a staff writer of the New York World-Telegram.

Much of this vital job, the writer says, grows out of the almost unbelievable versatility of the elder (Elmer) Sperry, who studied in the pioneer electrical engineering laboratory at Cornell for several months during 1879-80. A native of Cortland, N. Y., he held 380 patents in his own name when he died in 1930. Two sons, both Cornell graduates, are officials in the firm, Edward, M.E. '15, and Elmer, A.M. '15. Another official is Robert Lea, A.M. '15.

In the article special mention is made of the automatic gyropilot for airplanes, the Sperry bomb-sights, the 800 million-candlepower searchlights which reach four or five miles into the sky to pick out a target, anti-aircraft equipment, including efficient mechanical computers which predict the future position of an airplane target and make ballistic corrections for firing, and thousands of directional gyros and bank-and-climb indicators for airplanes.

Of the gyropilot the writer, Charles T. Lucey, tells the experience of an RAF Flight Lieutenant

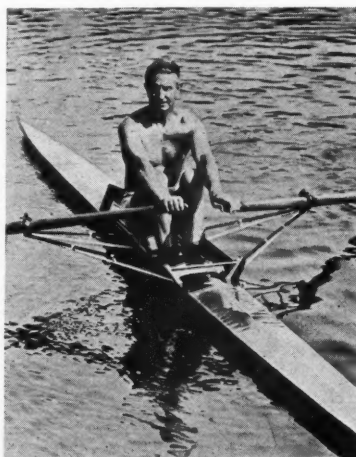
(Continued on page 26)

## Synthetic Rubber

IN A year-end statement of the progress made by the synthetic rubber program in the United States, John L. Collyer '17, who is president of the B. F. Goodrich Rubber Company, stated that although

rubber is still the principal supply problem, the nation is well on the way to what may be a permanent solution to the difficulties brought about when approximately ninety percent of the world's rubber supply fell into enemy hands last year.

So far most of the synthetic rubber produced has come from privately financed plants, and while it appears that only about 30,000 tons will be produced this year, the completion of government sponsored plants in the near future is expected to greatly increase this output. The rapid construction of syn-



—Courtesy Cornell Alumni News

John L. Collyer, M.E. '17

thetic rubber plants is of greatest value to the nation's military and civilian requirements and Mr. Collyer said that to avoid further serious delay the material needed for this construction must be made readily available.

The five outstanding developments in the nation's year old battle to "Keep 'em Rolling" were listed by Mr. Collyer as follows:

1. Complete stoppage of manufacture of passenger-car tires on December 12, 1941. In view of this it is indeed remarkable that the nation's rubber borne trans-

portation system was maintained, especially since the pre-war demand for replacement of tires was over 300,000,000 per year.

2. Successful inauguration of a large scale government financed plan for construction of synthetic rubber plants.
2. "Stretching" of existing stock piles by government action and civilian cooperation.
4. The nation-wide "pick up the rubber" salvage campaign.
5. Expansion of the available substances from which synthetic and natural rubber are produced.

## Midgley Receives Award

DR. THOMAS Midgley, Jr., M.E. '11, vice-president of the Ethyl Corporation and discoverer of tetraethyl lead, which has made possible great advances in automotive and aircraft engines, was recently elected president of the American Chemical Society for 1944.

In addition to the discovery of tetraethyl lead as an anti-knock agent, the new president has contributed largely to the knowledge of the chemistry of rubber and the methods of synthesizing rubber. Other of his achievements are the development of non-inflammable, non-toxic refrigerants and contributions to the methods of recovering bromine from sea water.

In recognition of his many accomplishments Dr. Midgley has received the Priestley Medal of the American Chemical Society, the William H. Nichols Medal of the Society's New York Section, the Perkin Medal of the Society of Chemical Industry, and the Longstreth Medal. Wooster College conferred the honorary degree of Doctor of Science on him in 1933.

After his graduation from Cornell he entered the employ of the

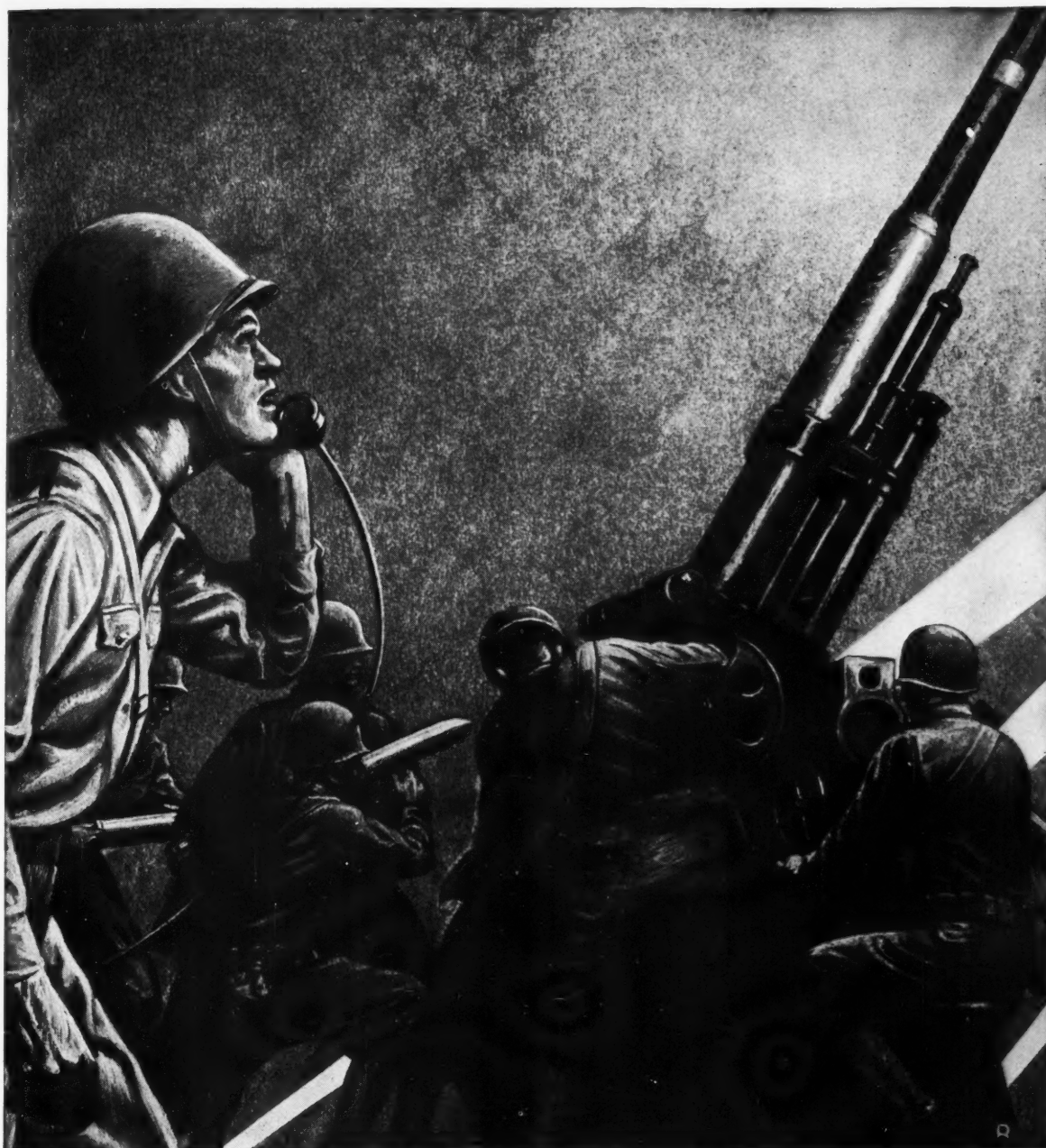
(Continued on page 26)

## Use The Cornell University Placement Bureau

WILLARD STRAIGHT HALL

H. H. WILLIAMS, '25 Director

*Every branch of the Armed Services uses the telephone. No. 1 of a series, Anti-Aircraft.*



To his mother and dad it seems only yesterday that he was using the family telephone to call his high school sweetheart. But today the orders he sends and receives over his wartime telephone help speed the day when love and laughter, peace and progress shall again rule the world.



**Western Electric**

IN PEACE...SOURCE OF SUPPLY FOR THE BELL SYSTEM  
IN WAR...ARSENAL OF COMMUNICATIONS EQUIPMENT





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# Nortons

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**For The Second Semester**

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You'll enjoy trading at the  
**TRIANGLE  
BOOK  
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Open Until 8:30 p.m. Est. 1903 Evan J. Morris, Prop.

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*Opposite "The Ithaca"*

Imported and Domestic—Wines  
**SCOTCH**  
Liquors

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*Buy a Case*  
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## "METALLIC VITAMINS" FOR INDUSTRY

So effective are relatively minute quantities of cemented carbides in stepping up—pepping up—production that they are often called the "metallic vitamins" of industry.

Because only small quantities are required per tool, Carboloy cemented carbides are measured in grams. A gram is 1/453rd part of a pound. A Carboloy tool tip weighing only 25 grams or slightly less than one ounce is a good size tip—enough to last for days, weeks—often months of cutting at speeds often higher than 4 to 5 times that possible with ordinary steel tools.

In terms of production, an ounce of cemented carbide can turn the turrets of dozens of tanks, or drill hundreds of guns, or turn as many as several hundred shell, or bore the cylinders of hundreds of "Jeep" cars. One ounce of carbide can do these and countless other crucial machining jobs faster and better than any other tool material.

These "metallic vitamins" also serve the cause of victory in many other ways. In masonry drills, they drill holes in concrete 75% faster for installing war production machinery. . . . In dies they speed up production of wire, cartridge cases, bullets, etc. . . . As wear-resistant inserts on vital machine parts, they

keep machines running. As a matrix material, they conserve diamonds, shorten operating time on mine drilling, dressing of grinding wheels, etc.

The myriad of present uses for Carboloy—the "metallic vitamin" of industry—now helping to speed the day of victory, forecast the steadily increasing diversity of benefits for the years of peace to come. ★ ★ Carboloy Company, Inc., Detroit, Mich. District Offices: Birmingham, Ala. • Chicago • Cleveland • Los Angeles • Newark • Philadelphia • Pittsburgh • Seattle.

### CARBOLOY TRAINING FILMS

A series of six Carboloy Training Films now available covering detailed, step-by-step procedure on the design, brazing, grinding, use and manufacture of cemented carbide tools, 35 mm silent slide films. (Not motion pictures.) Available for permanent use at approximate print cost of \$20 per set. Educational institutions may also secure sets on loan for single showings through selected college film loan libraries. Catalog and loan library listing on request. Write Carboloy Company Inc., Detroit, for Booklet "A".

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TRADEMARK



**CEMENTED CARBIDE**  
TOOLS • DIES • DRESSERS  
MASONRY DRILLS • WEAR PARTS

## SENIOR CLASS, 1943, SCHOOL OF CIVIL ENGINEERING

- |                           |                        |                       |
|---------------------------|------------------------|-----------------------|
| 1. Mangones, R. J.        | 13. Cohen, J.          | 25. Belt, D. H.       |
| 2. Hildabrand, T. J.      | 14. Nobis, T. O.       | 26. Brown, H. E.      |
| 3. Director W. L. Malcolm | 15. Findlay, R. C.     | 27. Gustafson, H. A.  |
| 4. Dean S. C. Hollister   | 16. Botsford, G. R.    | 28. Miller, E. A.     |
| 5. Prof. Seofield         | 17. Teeter, S. D.      | 29. Hoag, N. F.       |
| 6. Concors, A. F.         | 18. Machin, E. C., Jr. | 30. Kopczynski, A. J. |
| 7. Segal, S. J.           | 19. Filby, E. F.       | 31. Aisenberg, B. P.  |
| 8. MacCallum, R.          | 20. Arias, A.          | 32. Thalman, W.       |
| 9. Holden, J. I.          | 21. Harrow, T. T.      | 33. Hickman, R. E.    |
| 10. Hewett, R. W.         | 22. Pesant, E. A.      | 34. Palms, J. C.      |
| 11. Steele, R. D.         | 23. Whitney, J. S.     | 35. Baskous, A. A.    |
| 12. Nelson, R. L.         | 24. Conroy, H. M.      | 36. Correll, W. B.    |



## SENIOR CLASS, 1943, SCHOOL OF ELECTRICAL ENGINEERING

- |                         |                          |                           |                     |
|-------------------------|--------------------------|---------------------------|---------------------|
| 1. Hughes, R. W.        | 12. Schrader, L. W., Jr. | 23. Voelker, S. A.        | 34. Faulkner, F. K. |
| 2. Seeger, C. L., III   | 13. Eaton, R. C.         | 24. Lautz, C. F., Jr.     | 35. Baker, R. C.    |
| 3. Nairn, J. B. (A.E.)  | 14. Morrison, C. G.      | 25. Jones, C. R., Jr.     | 36. Whitney, D. B.  |
| 4. Dean S. C. Hollister | 15. Hirsch, H. M.        | 26. Kemon, S. B.          | 37. Just, G. A.     |
| 5. Director W. A. Lewis | 16. Graham, B. W.        | 27. Garnezy, R. H.        | 38. Brand, C. W.    |
| 6. Clement, R. R.       | 17. Hutton, R. E.        | 28. Rich, E. M. (A.E.)    | 39. Pohl, R. V.     |
| 7. Holmes, D. B.        | 18. Rogers, J. W.        | 29. Forrest, L. R. (A.E.) | 40. Olin, J. R.     |
| 8. Johnson, D. L.       | 19. Totah, E. J.         | 30. Wetmore, R. E.        | 41. Seldon, M. R.   |
| 9. Winokur, P., Jr.     | 20. Wheeler, D. B.       | 31. Margaris, A. G.       | 42. Best, R. L.     |
| 10. Witmer, F. S.       | 21. Walton, C. A.        | 32. Moore, W. J.          | 43. Swain, W. H.    |
| 11. Arbuckle, F. M.     | 22. Sailor, R. W., Jr.   | 33. Ryder, E. (A.E.)      |                     |

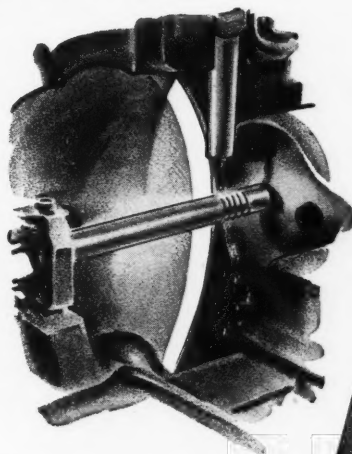
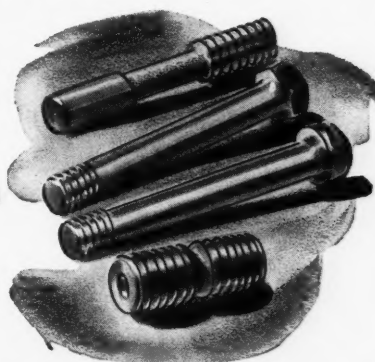


# He flies a plane held together with threads!



At 400 m.p.h. a fighter pilot's life literally hangs by a thread. For the bolts and studs which help hold his engine and plane together are only as strong as their threads. Fortunately those threads can be counted on to hold. A special grinding process makes them far safer and stronger today than they would have been a few years ago. In this process, Carborundum-made grinding wheels play an important role.

The method of grinding produces threads of almost unbelievable accuracy, free from microscopic checks and cracks which might cause failure under stress. This greater accuracy justifies a smaller safety factor, reducing weight of dead metal. And in most cases, production is speeded and costs reduced.



Thread grinding is typical of the many ways in which products and processes developed by Carborundum are serving America's war industry. When you get out in the field and encounter a production problem that abrasives might solve, write The Carborundum Company, Niagara Falls, New York.



Carborundum is a registered trade-mark of and indicates manufacture by The Carborundum Company.

## LUFKIN "RANGER" CHROME CLAD ENGINEER'S TAPE

Engineers who like a durable, compact, easily read steel tape take special note of the Lufkin "Ranger." Its sturdy, flexible steel line is  $\frac{1}{4}$ " wide with jet back markings that stand out prominently against the smooth, satin chrome surface. Graduations in feet, tenths and hundredths—or feet, inches and eighths. See it at your dealer's and write for free Catalog 12.



## SMALL TOOLS...



## VITAL

### TO OUR VAST WAR EFFORT

● Efficient small tools, such as "Greenfield" has been manufacturing for more than 70 years, are essential to America's armament program. "G. T. D. Greenfield" Taps, Dies, Twist Drills, Reamers and Gages are helping to build planes and tanks, ships and guns on a thousand "production fronts."

America's great metal working industry has learned by long, practical experience that the "G. T. D. Greenfield" trade mark means utmost reliability and accuracy in these vital tools.

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GREENFIELD, MASS., U. S. A.

**GTD GREENFIELD**

TAPS · DIES · GAGES · TWIST DRILLS · REAMERS · SCREW PLATES

## Midgley

(Continued from page 20)

National Cash Register Company of Dayton, Ohio. Later, with his father, he established the Midgley Tire and Rubber Company. In 1916 he began work under Charles F. Kettering with whom he has since been associated in various activities including the organization of the General Motors Research Corporation.

## Sperry Praised

(Continued from page 20)

over the Mediterranean one night. He was headed for Malta with medical supplies, concentrated foods, and high military personnel, when the big plane's electrical system, generators and all, quit dead on him. There was only the navigator and himself to handle the ship on the long, tough flight, ordinarily demanding a full crew.

"They were flying on instruments; but, with the electrical system dead, these could not be seen. A flashlight could show only one

spot on the big panel at a time; and three things might go haywire while one was being repaired.

"There was only one thing to do—hand the job to the automatic gyropilot and pray. It had accuracy no pilot could have in that darkness. And it took them through . . . down they came at last in a flare-path lighting a bomb-battered Malta flying field, gruelling hours after what might have been a disaster.

"The automatic pilots are being turned out in huge numbers in the big Sperry Corp., where a vigilant government draws the black shades on complex precision instruments of incredible accuracy that are helping American fighting men to outsmart Hitler. Some may not even be discussed, and only the most trusted employees know the others."

## Robert H. Flack

(Continued from page 15)

ness Competition. He succeeded in this, and rose to the position of Business Manager this year. In

that capacity he went out to Purdue University this fall to the Engineering College Magazines Association Convention; the trip was one of the highlights of his experiences as a Cornellian.

Bob hasn't wasted his summers at Cornell, either. During the summer of his Sophomore year he worked as a machinist's helper in Chicago and Iowa for the Chicago, Burlington, and Quincy Railroad. He hitchhiked to this job, and said that he remembered it most vividly as it was the first time he had tried that mode of travelling in his life. He liked the job, too, for railroads have always interested Bob. One of his hobbies is taking photographs of railroads and everything related to them.

His third summer he worked in Camden, N. J., for RCA as an inspector. This, he said, interested him so much that after the war he would like to get into the radio field. As it stands now Bob is headed for the U. S. Army Signal Corps immediately after graduation, where he hopes to get more experience in his chosen profession.

## ...and we made a Sapphire!

YOU'RE LOOKING at a sapphire being made in the incandescent heat of a specially designed furnace... a synthetic sapphire... better than the natural gem. It takes hours to grow one of these sapphire boules.

What's so wonderful about it? Sapphire is necessary for the security of this country. Out of this jewel stone are made hard, long-wearing bearings for precision instruments. The various precision devices of a modern battleship require more than 4,000 jewels; about 100 more are needed in fire-control mechanisms. Modern pursuit planes and bombers require up to 100 sapphire bearings in their instruments.

In 1940, this country was completely dependent upon Europe for sapphire jewels. The call went out for American-made sapphire to meet this nation's needs.

Because we at Linde are experienced in the production of gases and in the accurate control of high temperature gas flames, we volunteered to try to make sapphire. After two years of experimental research, we learned how to produce the high-purity raw materials needed and also how to make sapphire from those materials. Today, we make more synthetic sapphire than this country ever imported from Europe... enough to meet all industrial and military needs. Thus America need never again be dependent upon an outside source.

Right now, we make colorless sapphire because colorless jewels make harder bearings. No sapphire is available for anything but war production. In the future we stand ready to make ruby and other gem stone materials for the jewelry trade... and for you.

*This research development by The Linde Air Products Company is paralleled by other recent achievements of Electro Metallurgical Company, Carbide and Carbon Chemicals Corporation, and National Carbon Company, Inc.—all of which are Units of Union Carbide and Carbon Corporation.*

**THE LINDE AIR PRODUCTS COMPANY**  
Unit of Union Carbide and Carbon Corporation

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**HIS BEARINGS ARE RIGHT**—Chronometers, compasses, and other navigational aids must be rugged as well as precise. Sapphire bearings can "take it."



**FLYING JEWELS**—Pilots' lives and the success of their missions depend upon accurate instruments. Sapphire bearings assure continued accuracy.



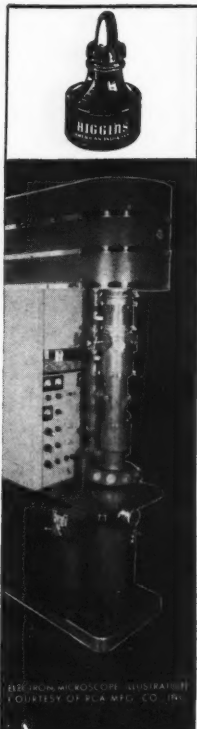
**LABORATORY WARRIORS**—Delicate balances, time instruments, and other important precision equipment of the research worker need sapphire jewels, too.



**YOURS IN THE FUTURE**—Flawless gems... such as rubies, sapphires, and spinel... made by this same Linde process... will be available for jewelry in the future.

**BUY UNITED STATES WAR BONDS AND STAMPS**





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### Power

(Continued from page 7)

operators in the substations.

It may be of interest to describe the procedure which is followed in the event of a practice blackout, or an actual air raid. In certain offices such as those of the trainmaster and the power system operator a signal instrument has been installed for the purpose of giving advance warning of air raids. This device consists of two ordinary telephone boxes, one containing a buzzer and the other a bell. Upon an impending air raid a first caution warning signal consisting of long interrupted buzzing signals is received. A second caution warning signal consists of short rapid buzzing signals. The third or actual action signal consists of long interrupted ringing signals. Upon receipt of the action signal the trainmaster sends a signal out on what is known as the block alarm system, which rings a bell in each station agents office. Upon receiving this signal each station agent places a red lantern on his platform and upon seeing the red lanterns the motormen hold their trains in the

stations. After sending out the alarm on the block alarm system the trainmaster then telephones the power system operator that he is to order all power off the third rail and off the lighting feeders at a definite time which time is fixed at five minutes after the action signal on the air raid alarm system. The System Operator in turn telephones all substations and orders them to open all third rail and lighting feeder switches at the time fixed by the trainmaster. The power system operator is able to talk to eight substations at the same time by telephone so that he can transit his orders to all substations within a very short time. Each power station is also notified by an alarm system and all men take positions in which they will be protected from falling glass, etc. in the event of an actual air raid. Upon receipt of the all clear signal over the air raid alarm system, the trainmaster sends a signal over the block alarm system upon receipt of which the station agents remove the red lanterns from the station platforms. He also notifies the power system operator who imme-

diately orders all substations to restore all third rail and lighting feeds. Upon the restoration of the power the motormen are free to resume service.

In closing it may be well to give figures which will give some conception of the magnitude of the power requirements of the New York City Transit System. The chart shows the power requirements of the system for a typical winter day and indicates how it varies from hour to hour. The annual power consumption of the system which carries over two billion passengers a year is over two billion kw-hrs. requiring about a million and a quarter long tons of coal for its production.

### "E" Award

CRUCIBLE Steel Co. of America's Atha Works, of which a prominent Cornell graduate is president, has received the Army-Navy "E" pennant for excellence in production.

The Cornellian is Frederick B. Hufnagel, M.E. '09. He has been president of Crucible Steel for the past 16 years.

**THE CORNELL ENGINEER**

**TODAY DEMANDS PRODUCTION AND ACCURACY**  
— Use No 12 Plains for your quality milling



Brown & Sharpe Mfg. Co.  
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**BROWN & SHARPE**

# Your future is not forgotten

## ★ A MESSAGE TO MEN IN COLLEGE

There will be a future.

The very service you are being called upon to render to your country is assurance of that. We know the stuff you're made of, because we have watched two generations of college men join our ranks and grow with us.

And the materiel which we older men in industry are pouring out makes assurance doubly sure.

What kind of future will you have?

By chapter and verse, no one can recite *exactly*. But a lot of folks like us mean to see that Opportunity is going to be greater than any generation of young men has ever known.

Every hour of thinking time we can catch on the fly is devoted to that one aim. Here at

Alcoa we call it Imagineering. We are letting our imagination soar, and ballasting it with engineering experience. Our purpose is to make aluminum make jobs where none ever existed before.

The exciting new uses we glimpse for Alcoa Aluminum are our part of the groundwork of the structure of peace you will come back to help to build.

Your chance is going to be the creative chance. The materials, the tools, the techniques, will be ready and waiting. Your imagination, your ingenuity, your courage to do, cannot, must not, fail to have their turn.

As man to man we say it, soberly: Your future is not forgotten.

*A PARENTHETICAL ASIDE: FROM THE AUTOBIOGRAPHY OF*



# ALCOA ALUMINUM

• This message is printed by Aluminum Company of America to help people to understand *what we do* and *what sort of men* make aluminum grow in usefulness.



**HARRISBURG MAKES . . . Alloy and Carbon Steel Billets: Seamless Steel Cylinders, Liquefiers, Pipe Couplings and Pump Liners: Hollow and Drop Forgings: Pipe Flange: Coils and Bends.**



**THIS 102-PAGE CATALOG IS FREE. SEND FOR IT . . .** Contains official S. A. E. Standard Specifications; information on Cylinders, Flanges, Couplings, Pump Liners: up-to-date data on the Liquefier. Well illustrated. An important reference book to have in your possession.



**HARRISBURG STEEL CORPORATION**  
HARRISBURG, PENNSYLVANIA

## President's Message

(Continued from page 18)

lege, Veterinary College, and College of Engineering will doubtless continue to operate at capacity, as will some of the science departments in the College of Arts and Sciences. But other divisions, such as the Law School and various departments offering courses in liberal arts, will be handling few if any students.

"Cornell must therefore, in the next few months, squarely face this question: Can we afford to eliminate all departments not directly used to train men for the Army and Navy? Surely the answer is no. The University must continue courses needed by women students, and must also supply training for men physically disqualified for military service but useful in war industries and in essential civilian services; and such training will be considerably broader than that demanded by the Army and Navy. Cornell has an obligation to these students, even though their numbers will probably not justify the expense of continuing some of the kinds of instruction they may desire.

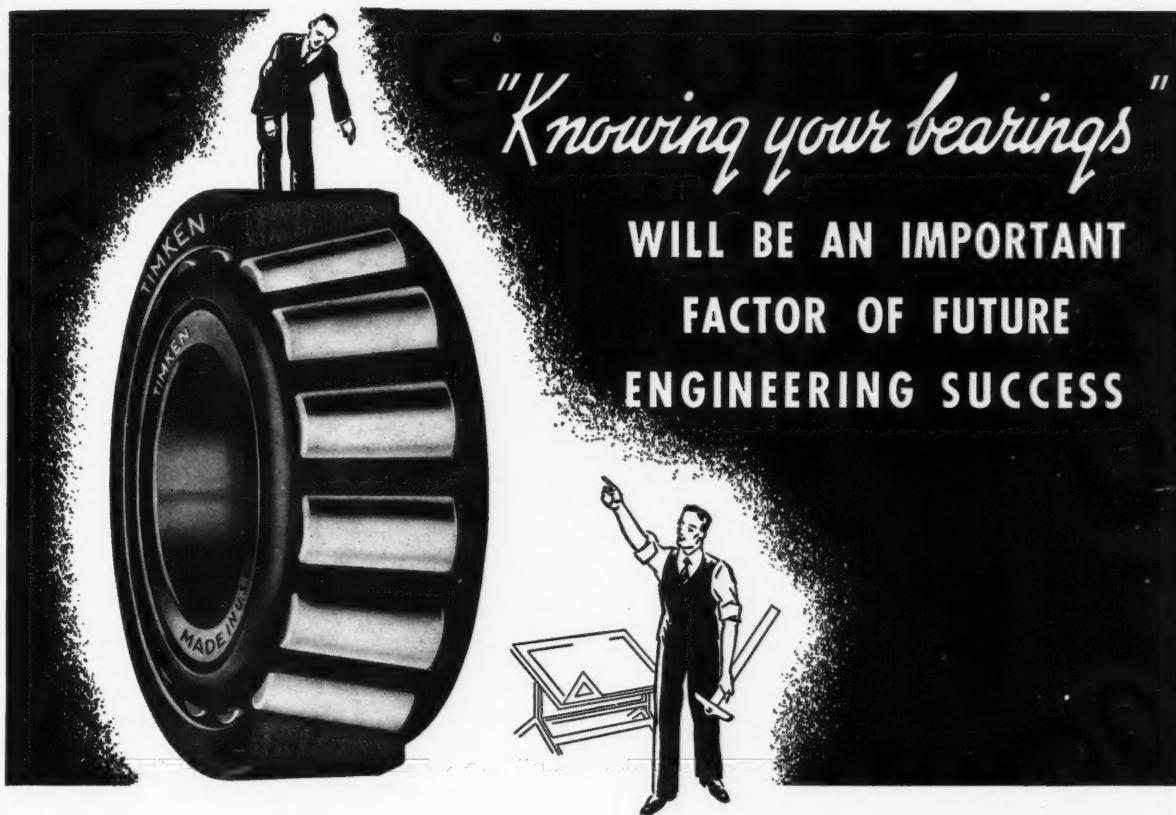
But Cornell has an even greater obligation to its own tradition and to the future welfare of the nation. We cannot afford to allow our distinguished faculties in the arts and humanities to be entirely dispersed. We must be ready, as soon as the war is won, to reestablish those departments whose primary function is to promote humane and rational living. We shall not be able to do this if the long-term, basic functions of the University go into total eclipse for the duration of the war. Distinguished faculties cannot be built overnight. Cornell's ablest scholars and scientists must be protected now if they are to serve Cornell tomorrow. Their perspective, their judgment, and their knowledge will be needed in the postwar world."

It is, therefore, quite necessary, if the Cornell Engineering College is to maintain its position in the educational world, that means be found to continue its teaching in the atmosphere of a great University.

Sincerely yours,  
G. N. BROWN,  
President

**THE CORNELL ENGINEER**





The terrific strain of modern war is testing American mechanical equipment of all kinds as it never has been tested before, but it is coming through with flying colors.

For, among other vitally important things, the designers of this equipment *know their bearings*; that is why so many Timken Tapered Roller Bearings are used in tanks, trucks, armored cars, guns, airplanes, warships and the machines that make them. Timken Bearings meet every bearing requirement because, in addition to eliminating friction they carry radial, thrust and combined loads and hold moving parts in correct and constant alignment.

Timken Roller Bearings have been solving

bearing problems in industrial and transportation equipment for many years—long before the first world war. They will be called upon more and more during the reconstruction period that will follow Victory for the United Nations in the present conflict.

That is why you should begin now to acquire a thorough knowledge of Timken Tapered Roller Bearings — their design and application. When you have this knowledge you will be able successfully to meet any bearing condition you ever may encounter. Our engineers will help you to get it. The Timken Roller Bearing Company, Canton, Ohio.

**"All There Is In Bearings"**

**TIMKEN**  
TRADE-MARK REG. U. S. PAT. OFF.  
**TAPERED ROLLER BEARINGS**

Manufacturers of Timken Tapered Roller Bearings for automobiles, motor trucks, railroad cars and locomotives and all kinds of industrial machinery; Timken Alloy Steels and Carbon and Alloy Seamless Tubing; and Timken Rock Bits.

# STRESS *and* STRAIN...

"Do you know what a skunk is?"  
 "No."  
 "A two toned job with fluid drive."

\* \* \*

Bill: "So, what did you do when her dress started coming off?"

Tom: "I helped her out the best I could."

\* \* \*

A woman came into the doctor's office and told the medico she needed an operation."

"Major?" he asked.

"No, Second Lieutenant," she replied.

\* \* \*

What has more fun than people do?

Rabbits.

Do you know why?

Because there are more rabbits than people.

Do you know why?

Because rabbits have more fun than people do.

\* \* \*

"Another combination shot," said the coed as she leaned too far over the billiard table.

\* \* \*

## ONE FOR THE RAIDERS

Why the toothbrush in your lapel?

It's my class pin—I go to Colgate.

\* \* \*

Perhaps you've heard of the Scotchman who visited Paris on the hottest day on record because the Eiffel Tower was eight inches higher than in January.

\* \* \*

Skidding is the action,  
 When the friction is a fraction  
 Of the vertical reaction,  
 Which results in traction.

—*Illinois Tech Engineer*

\* \* \*

Hitler was making a tour of a German lunatic asylum. All the inmates lined up and, as soon as the Dictator appeared, stood smartly at attention and gave the Nazi

salute. All, that is, except one man at the end of the line.

"Hi!" screamed Adolph. "Why aren't you saluting?"

"Don't be silly," said the man. "I'm one of the guards here, not one of the inmates!"

\* \* \*

U.S.O. Hostess: "So you are on a submarine. What do you do?"

Sailor: "Oh, I run forward ma'am, and hold her nose when we want to take a dive."

\* \* \*

"PEEP" is a number 14 roller skate equipped with a motor, mud guards, windshield, and place to seat two heels instead of one.

\* \* \*

Madam, will you please get off my foot?

Why don't you put it where it belongs?

Don't tempt me, lady, don't tempt me.

\* \* \*

A drunk staggering along the street, bumped into a telephone pole.

After falling around it several times, he muttered, "S'no use. Walled in."

\* \* \*

A newly inducted parachutist received terse orders from his commanding officer before his first jump.

"Remember," he was told, "pull the first rip-cord after you count to ten. If the chute doesn't open, pull the second cord. When you land, a jeep will be waiting to bring you back to camp. That is all."

Our soldier jumped. He counted to ten very slowly and pulled the cord. Nothing happened. He pulled the second cord. Nothing happened.

"Jehosephat!" he muttered. "I bet the jeep won't be there either."

Coed to roommate: "I don't care much for that engineer you've been dating lately. He whistles dirty songs."

\* \* \*

An optimist is one who thinks this is the best of all possible worlds.

A pessimist is one who is afraid he is right.

\* \* \*

Special Bulletin: In view of the present emergency, a new course, Commando Tactics, is being offered. Designed primarily to better prepare the student for the scientific warfare of today, the course will include Eye-poking I, Tongue Surgery I, Meat-chopping I, and General Amputations. Advanced courses will be open to the more proficient students.

\* \* \*

And then there was the absent-minded student who lathered up and shaved it all off with a safety razor minus the blade.

\* \* \*

Drunk in a telephone booth: "Number hell . . . I want my peanuts."

\* \* \*

I wish I were a kangaroo.

Despite his funny stances,  
 I'd have a place to put the junk  
 My girl takes to dances.

—*Iowa Engineer*

\* \* \*

Engineer: "Is the dance formal or can I wear my own clothes?"

\* \* \*

The company cook brought in a plateful of extremely thin slices of bread and butter, which rather dismayed his hungry battalion.

"Did you cut these, Sergeant?" asked one.

"Yes, I cut them," came the stern reply.

"Oh," went on the soldier, "All right—I'll shuffle and deal!"

## CUTTING TOOLS THAT NEVER DULL



**F**ASTER than ever before—and with fewer delays—man shapes steel with the Airco oxyacetylene flame. There's no time out for sharpening or regrinding when this modern cutting tool is on the job. Here the Radiagraph—an Airco achievement—is depicted utilizing the oxyacetylene flame to perform a highly specialized cutting operation. So versatile is the standard machine that it does the job speedily, accurately without the aid of special attachments.

New, faster, better ways of making

machines, engines, ships, tanks and guns result directly from using this "never dull" production tool. So varied is its application that, in addition to cutting steel swiftly and accurately, the oxyacetylene flame hardens steel to an easily controllable depth, cleans metal surfaces for longer lasting paint jobs, welds metal into a strong, lasting structure. To better acquaint you with the many things that this modern production tool does better we have published "Airco in the News", a pictorial review in book form. Write for a copy.



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**ANYTHING AND EVERYTHING FOR GAS WELDING OR CUTTING AND ARC WELDING**



# G-E Campus News



## MERRY-GO-WHEEL

A DEVICE that rotates in the manner of a combination merry-go-round and Ferris wheel has been developed to speed the drilling of marine gear casings at one of General Electric's major plants.

Known as a universal indexing trunnion fixture, the device permits quick moving of the casings for drilling at any angle in a full circle and on any plane. Movement is controlled by a push-button.

About 110 holes must be drilled and tapped in each of the casings. Formerly it took a crane to move the casings (which vary in weight from 1000 to 2000 lb) after each surface was drilled, and every piece of work had to be set up at least six times.

Now work is set up just once—on a table that can be turned completely around in either direction with no more effort than it takes to push a revolving door—and 24 to 32 hours a week are saved.



## THE BETTER TO SEE WITH

PARTICLES as small as one millionth of an inch—one thousandth of the diameter of a human hair—can be clearly seen with the new G-E electron microscope.

Developed by Drs. C. H. Bachman (Iowa State, '32) and Simon Ramo (U. of Utah, '33), the new instrument can magnify a specimen as much as 10,000 times and reveal the actual composition and structure of such minute things as dust and smoke particles.

Here's how it works: a beam of electrons inside a vacuum chamber passes through the specimen, passes through an "electron lens," and produces a magnified picture on a fluorescent view screen. This image can then be photographed outside the tube and enlarged up to 100,000 times the size of the original specimen.

The microscope, designed for use in small laboratories and war plants, is portable and operates on ordinary house current.



## THE LIGHT FANTASTIC

ACTUALLY it's just an ordinary light bulb, but used in an indicating method developed by a G-E foreman, it helps minimize errors in precision lathe work requiring an accuracy of five one hundred thousandths of an inch.

This new method eliminates the human element inherent in the old practice of using a magnifying glass to see when the tool makes contact with the surface to be cut.

In this indicating method, electrical contact between tool and work is used to close a light circuit. The tool is brought up to the surface to be cut in the regular manner until it is just about to make contact. From this point on it is brought up very slowly until the pilot light flickers.

When the light is steady, the indicator is set at zero; and if it is set and read correctly, there can be no error.

If you'd like to try this on your own machine-shop equipment, write for a free diagram and description to Campus News, General Electric Co., Schenectady, N. Y.

# GENERAL ELECTRIC

908-44-211



